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### Efficiency of mill practice in the Joplin District

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**THESIS**

FOR THE

**Degree of Bachelor of Science**

IN

**MINE ENGINEERING.**

IRA LEE WRIGHT.

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SUBJECT.

"Efficiency of Mill Practice in the Joplin District."

7500

JUNE, 1907.

MIN.  
JUNIOR  
COLLEGE

Joplin, Mo., May 27, 1907.

### Mill Practice in Joplin.

Milling in the Joplin District is, compared with the practice in other zinc fields, seemingly very crude. To one unacquainted with the peculiar conditions of this district, the amount of ore which goes into the tailing pile seems unnecessarily high. There are several things which account for the low saving made.

First, the nature of the ore deposits do not as a rule warrant large expenditures on concentrating machinery. It is impossible to tell beforehand what a mine is going to produce and so the mill is never so elaborately designed as in other districts where exploration work is carried on sufficiently to enable the operator to estimate what his mill will be called upon to perform.

Second, most of the mines are operated on small capital. The first cost of the mill must necessarily be low, and the daily cost of operation is kept as low as possible.

Third, very high concentration is obtained and always where this is done the loss in the tailings is increased. Blende concentrates assay on an average throughout the district, 60% zinc. Galena concentrates 80% Pb.

Fourth, the margin of profit over the cost of mining and milling may be low. Therefore, in order to operate on a paying basis, it is essential that the mill treat as much ore as possible. In a great many of the mills, an additional saving of 2 or 3% would not pay for the decrease in capacity as additional labor and expense necessitated thereby. Out of these conditions has been evolved a type of mill, which, though its efficiency may be low, successfully meets the requirements of the district. It is a striking fact that nearly all the mills are built on exactly the same plan. It is very seldom that any plans whatever, are needed for the construction of a mill.

An experienced contractor knowing exactly what arrangement of the machinery to make.

#### Location.

The mill is almost invariably located at the mine, the hoisting bucket being dumped directly into the bin. In some cases where new shafts have been sunk, or where two or more shafts furnish ore for one mill, the ore is dumped into a car which is pulled up an incline to the mill bin. There are one or two custom mills in the district that mill ore for a price per ton. These are owned by land companies from which the operators lease mining lots, and have their ore milled at the Company's mill. Ore is hauled to the mill in wagons. In general the location of the ore body determines the location of both mine and mill.

Water is often obtained from the mine in sufficient quantity to run the mill. In some cases where a stream is near enough, a pumping plant is installed and water pumped to the mill. Where neither of these conditions exists a well is bored.

Concentrates from the mills are hauled by wagons to the nearest R. R. station. The ore buyers pay for hauling. Timber, fuel, and other supplies must of course be brought in by wagon.

#### Character of ore.

Chert, limestone and clay occurs as gangue material. The most common is chert, which occurs as a very hard crystalline mass. Blende and Galena are the valuable minerals, and occur in a coarsely crystalline condition. Large masses of pure blende or galena are often found. Zinc silicate occurs in sufficient quantities as to be of economic importance. The richness of the ore bodies is by no means uniform. It varies indefinitely even in the same mine.

#### Hoisting.

Very few shafts have more than one hoisting compartment. All necessary piping is put down in the same compartment as that in which

### Concentrates.

As previously stated a very high degree of concentration is obtained. They contain very little or no iron. An average of 60% Pb. A very complete separation of Blende and Galena is made.

### Tailings.

The mills in the district are built on level ground which necessitates an elevator 50 or 60' high in order to dispose of the tailings. They are sluiced out to heaps and allowed to accumulate in a heap around the mill. Assays of tailings in the district vary from 1 to 4% zinc.

### Power.

Steam is most commonly used although it is far more costly than gas used in gas engines. The frequent break-downs of gas engines seems to have limited their use somewhat. A great part of these is probably due to the ignorance of the attendant and it is very probable that the use of the gas engine will become more prevalent as the operators get a better knowledge of them. The Missouri Lead and Zinc Co. furnishes electric power from their own power plant to the leasees on their ground. Their mill also uses electric power. I have not been able to get any data as to the relative cost per H. P. of steam, electricity and gas; but there seems little doubt of the greater cheapness of the latter.

### Fuel.

Coal and gas are the fuels used. Good lump coal costs from \$2.00 to \$2.25 f. o. b. cars Joplin. The cost of hauling would bring it up considerable more depending on the location of the mill.

Natural gas costs 15 ¢ per 1000 cu. ft. at 8 oz. pressure. There are mains leading all over the district so that pipe lines can be laid to them from the mills at a small cost. It makes an ideal fuel as no fireman is required, and it can be regulated to give a constant steam pressure.

### Examples of Mills.

The following two mills are thought to be good representatives of mills working in the two different kind of formations--sheet and pocket ground.

the hoisting is done. The ore is hoisted in cans which hold about 1000<sup>lb</sup>.

A good man can hoist 175 tons per shift of eight hours. The hoisting engine is located on a derrick on the same level as that to which the bucket is elevated. The bucket is dumped by moving to one side and hooking a rope to the eye on the bottom, and then letting it down. This upsets the bucket, and the ore falls on the grizzly.

#### Spalling Floor.

The grizzly upon which the ore falls from the bucket consists of 3/4 x 4" bars set about 4" apart and sloping about 45 degrees. The oversize rolls down on to another grizzly, made of very heavy round bars on railroad rails and set about 6" apart. Boulders which will not pass through are broken by spalling. Two men are usually employed for this work. Some hand picking is done here, the barren boulders being wheeled out and dumped on the boulder pile.

#### Bins.

The bin is usually large enough for a day's run. It is supported on 8x8 timbers about 3 1/2' apart. The bottom slopes at an angle of 45 degrees and is usually lined with sheet iron.

#### Crushing.

Ore is fed from the gate down a sluice to the crusher. Usually a feeder is employed to regulate the feed to the crusher but sometimes automatic feeders are used. Jaw crushers are used altogether. For a 250 ton mill one 18"x24" crusher will do the work where the ore is delivered to the rolls. For the above crusher two 36" rolls are required. These deliver to a revolving screen with 1/2" perforations, the oversize being returned to the rolls. These screens are made of sheet iron with 1/2" perforations punched in it. They are about 6' long 3' in diameter and run at about 30 R. P. M.

#### Jigging.

From the screen the undersize goes to the roughing jig. The jigs

used in this district are of the Cooley type. The casing is made of 2"x4" pieces laid flatways. These are very solid and water tight. The compartments are usually about 30"x48" in size. The speed of the roughing jig is about 140 to 175 R. P. M. Four and five mesh screen are used as grates. Sometimes concentrates are taken from the first two compartments but usually all the lutch product is sent to the cleaning jig. Chats are sent to the chat rolls. Tailings go to the tailing elevator.

The cleaning jig uses 8 to 12 mesh screen and the speed is faster than that of the roughing jig. They consist of from four to seven compartments and all of them may make concentrates but it is customary to send the last compartment to the sand jig if such a jig is used. If the ore contains lead the first compartment turns it out. Chats from the roughing jig and the chats and tailings from the sand jig go to a sizing screen. This is usually a revolving screen containing about 3/16 perforations. The over size from this screen goes back to the chat rolls and the undersize to the sand jig. This jig has about 12 mesh screens and runs at about 180 R. P. M. All the compartments, which are usually four in number, make concentrates. The tailings are sent to settling tanks from the settlings are drawn off and treated on tables. The Wilfley and Kirk tables are the common ones used. The former makes a very clean separation of chat and concentrates but has a small capacity. The latter has a large capacity but does not make so clean a separation. This table also separates blende and galena, which is usually not done with the Wilfley.

#### Efficiency of Concentration.

On account of the wide variation in the ores of this district, it is impossible to get a reliable average percentage of extraction. The ore is too irregular for sampling. Ingalls estimates the average as 4.6%. The tailings vary all the way from 1 to 4% zinc. Writers upon the subject vary between 70 and 80% in their estimates. All figures which I have been able to obtain give about 66% as the average.

### Davey #3.

This mill is owned by the American Zinc, Lead & Smelting Co. and is located near Carterville in the sheet ground formation. The capacity is nominally 400 tons per day, but the average days run is 275 tons. The gangue material is limestone and clay and contains both blende and galena. The concentrates saved from the ore for the month of January, '07, averaged 1.3% blende and .9% galena. 25680 tubs of ore averaging 1000# to the can were hoisted, 325000# blende and 245500# galena were sold.

The shaft has two hoisting compartments, the ore being hoisted in cans in the ordinary way. The ore is dumped over grizzlies with bars 6" apart. Two men are employed for spalling and one for disposing of waste boulders. The ore falls through the grizzley into a bin of 400 tons capacity. The bottom of this bin slopes one way only and at an inclination of 45degrees.

One man is employed to feed the two jaw crushers used. These crushers are 18"x24". Each delivers to an 18" elevator which delivers to a revolving screen. These screens are 6' long, 3' in diameter, and revolve at 32 R. P. M. The first three feet of the screen is perforated with 5/8" holes and the last 3' with 1/2" holes. The oversize from the screen goes to 36" rolls. There are three of these rolls only two being used at one time, while the other is being repaired if need be. The product from the rolls returns to the screens. The undersize from the screens runs to two roughing jigs which consists of six 30"x42" compartments. The screens are 8 mesh and the piston speed is 108 R. P. M. The first compartment turns out galena and the other five blende, all of which is sent to the cleaning jig. Bed stuff or coarse concentrates are taken out from the first four compartments. Chats are sent to the chat rolls.

The cleaning jig has seven compartments, the last two being belted separate and run as a sand jig. The speed of the cleaner compartments is 150 R. P. M. and that of the sand compartments 175 R. P. M. The first two compartments of the cleaner turns out galena and the others blende.



Tailings from the sand jig compartments go to the settling tanks from which the settlings are delivered to Kirk tables. Two of these tables are employed and they make blende, galena, middlings, and tailings, the middlings being returned. These tables are reported to be doing very good work at this mill. A 14"x36" Corliss Engine, generating 135 H. P. is used for driving the main shaft. Steam is generated at 100 H. P. in 6 125 H. P. gas fired boilers.

Blende concentrates run 58% zinc and about 5% "mundic". Galena concentrates run 80.5% Pb. Tailings run 1% zinc. The average cost of milling is 18¢ per ton of ore.

#### Midnight Mill.

This mill, located 1/2 mile south of Zircite, is owned by Dr. G. E. Ladd. The ground is a pocket formation, and the ore is extremely rich. Both blende and galena occur.

The nominal capacity is 150 tons but 75 tons is the most that has ever been run through in the <sup>two</sup> weeks the mill has been in operation. There is one elevating shaft, the ore being dumped over a grizzly having bars 6" apart. Two boulder breakers are employed on each shift. The bin has a capacity of 125 tons and the floor slopes only one way at an inclination of 45 degrees. The ore is delivered from the bin to a about 14"x30" jaw crusher which crushes to about 1" and delivers to a set of 30" rolls and there delivers to a revolving screen having 1/2" perforations. The oversize is sent to a second set of 30" rolls which delivers again to the revolving screen. The undersize from the screen goes to the roughing jig, which consists of five 36"x48" compartments and runs at a speed of 150 R. P. M. The grates are 3/16" mesh screen. The hutch product from the jig goes to the cleaning jig. The bed stuff in the first compartment is galena and in the other two blende concentrates. The bed stuff in the other two is sent to the chat rolls.

The cleaning jig has seven compartments 28"x42" and has a speed of 120 R. P. M. All the compartments of this jig make concentrates except

the last one from which the stuff is sent to the sand jig. Galena is taken from the first compartments. The tailings from the cleaning jig is sent to a revolving screen having 1/16" perforations. Oversize from this screen is sent back to the rolls and the undersize to the sand jig which consists of four 24"x30" compartments. 5 mesh screens are used, and the speed is 150 R. P. M. The tailings are sent to a settling tank from which the settlings are sent to a shaking screen which is made of 20 mesh screen. The undersize goes to a Wilfley table. No separation of blende and galena is made on the table.

Water for this mill is obtained from Turkey Creek which is about 2000' from the mill. A two stage centrifugal pump operated by a 25 H. P. gas engine is used. The lift to the pond at the mill is 95'.

Steam power is used at the mill. Two gas fired boilers furnish steam at 100% pressure. The blende concentrates assay 59% zinc and about 1% pyrite. Considerable galena concentrates assaying about 60% Pb. are made.